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Infection of sorghum seeds by *Colletotrichum graminicola* 1. Survey, location in seed and transmission of the pathogen

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Summary

Infection of sorghum seeds by *Colletotrichum graminicola*, ranging from 0.5% to 35%, was detected in 20 out of 71 samples from Colombia, Ghana, India, Nigeria, Sierra Leone, Thailand, the United States and Vietnam. The fungus was present mainly in the pericarp, occasionally in the endosperm, and in rare cases in the embryo. In two heavily infected samples, 55% seed rot and 45% seedling mortality was observed. Seed transmission was demonstrated by the water agar seedling symptom test and in a pot experiment. The possibility of two types of disease cycle is suggested.

Résumé

Infection des semences de sorgho par Colletotrichum graminicola *I. Enquête, localisation dans les semences et transmission de l'organisme pathogène.*

Une infection des semences de sorgho par *Colletotrichum graminicola* comprise entre 0,5 et 35% a été détectée dans 20 échantillons sur 71 provenant de Colombie, du Ghana, de l'Inde, du Nigéria, de la Sierra Leone, de la Thaïlande, des Etats-Unis et du Vietnam. Le champignon était localisé principalement dans le péricarpe, occasionnellement dans l'endosperme et, dans de rares cas, dans l'embryon. Dans deux échantillons fortement infectés, on a observé 55% de semences pourries et 45% de plantules mortes. On a démontré la transmission par les semences à l'aide du test des symptômes sur plantules en milieu eau gélosée et d'un essai en pots. Les résultats suggèrent la possibilité de deux types de cycle de maladie.

Zusammenfassung

Die Infektion von Sorghum-Saatgut durch Colletotrichum graminicola. *1. Übersicht, Lokalisierung am Samen und Übertragung des Erregers.*

Eine Infektion von Sorghum-Saatgut durch *Colletotrichum graminicola*, welche von 0,5% bis 35% reichte, wurde bei 20 von 71 Proben aus Kolumbien, Ghana, Nigeria, Sierra Leone, Thailand, den Vereinigten Staaten und Vietnam festgestellt. Der Pilz befand sich hauptsächlich Perikarp, gelegentlich im Endosperm und in seltenen Fällen im Embryo. Bei zwei schwer infizierten Proben wurde 55% Samenfäule und 45% Keimlingssterblichkeit beobachtet. Die Übertragung durch Saatgut wurde durch den Wasseragar-Keimlingssymptomtest und in einem Topfversuch demonstriert. Er läßt sich die Möglichkeit von zwei Typen des Krankheitszyklus vermuten.

Introduction

Anthracnose of sorghum (*Sorghum* spp.) incited by *Colletotrichum graminicola* (Ces.) Wils. causes heavy losses in the crop (Tarr, 1962). The pathogen usually persists in soil, infected crop residues and on weed hosts. Luthra (1932) reported that the life cycle of the pathogen in Sudan grass (*Sorghum sudanense* (Piper) Stapf) indicates that it is seed-borne. Chilton (1940) isolated it from seeds of Sudan grass and the pathogen is included in the annotated list of seed-borne diseases of *Sorghum* spp. by Noble and Richardson (1968). However, experimental data on actual seed transmission seem to be lacking. In order to obtain the needed information, seed samples of sorghum from different countries were collected to assess seed infection by *C. graminicola*, its location in the seed and its transmission from seed to seedling.

Materials and methods

Seed samples of *Sorghum bicolor* (L.) Moench from Colombia (3), Egypt (1), Ghana (7), India (19), Indonesia (2), Nigeria (1), Sierra Leone (3), Sudan (2), Thailand (26), Uganda (2), the United States (8) and Vietnam (1) were tested by the standard blotter method (International Seed Testing Association, 1966), using 200 seeds per sample. The pathogen was identified, based on the criterion suggested by Kulshrestha, Mathur and Neergaard (1976) and this identification was confirmed by examining conidia under a compound microscope.

Two samples obtained from Mr. J. F. Schoen of the US Department of Agriculture, Beltsville, were used for component plating. The technique developed by Mathur, Mathur and Neergaard (1975) was followed to locate sites of infection in seed. Transmission of the pathogen was studied on 1% water agar in plastic petri dishes by the method described by Khare, Mathur and Neergaard (1977). Observations were recorded after 12 days of incubation.

Two hundred seeds and seedlings infected with *C. graminicola* from the blotter test were carefully transferred to peat soil in pots, kept at 25 °C in an environmental controlled room under 12 hours of artificial daylight (supplied from two cool, white fluorescent Phillips TLF 40 W/43 deluxe tubes) and 12 hours darkness daily. Observations on the appearance of symptoms and development of the pathogen on diseased tissues were recorded at intervals. Isolations were made from dead seeds and different parts of seedlings, after careful washing in running water and subsequent disinfection in a sodium hypochlorite solution (2% available chlorine) for two minutes. Plating was done on potato dextrose agar and incubation was at 20 °C.

Results

Out of 71 samples tested, 20 showed infection of *C. graminicola* which varied from 0.5% to 35.0% (table 1).

Out of 150 and 400 seeds of samples No. 10045 and 10046 tested for location of

Table 1. Percentage infection of *Colletotrichum graminicola* in seeds of sorghum from different countries tested by the standard blotter method. Observation based on 200 seeds.

Sample accession number	Country	Cultivar	Infection percentage
8667	Colombia	E 57 Proacol 255	6.0
8668	,,	ICA Nataima, Colsemillas 25	0.5
4212	Ghana	K 24	2.0
4215	,,	MAR 006	2.5
4216	,,	K 9	1.5
9576	,,	Naga White	2.0
9577	,,	Naga White	2.0
7845	India	40-1-743	2.0
7852	,,	47, SB 412	1.0
6385	Sierra Leone	Local	0.5
6386	,, ,,	Local	0.5
6391	,, ,,	Local	1.0
10008	United States	NKS 3183	0.5
10009	,, ,,	B 3197	3.0
1966	Vietnam	Early Hegari	1.0
2167	Nigeria		0.5
8503	Thailand	Early Kalo	1.0
8519	,,	No 84	1.0
10045	United States	Martin B 66138	35.0
10046	,, ,,	Martin B 66139	23.5

C. graminicola, 69 and 153 seeds respectively were found to be infected. The percentage recovery of the pathogen from different parts was calculated on the basis of infected seeds (table 2). The pathogen was present in all parts, mainly in the pericarp and extremely rarely in the embryos.

In the water agar seedling symptom test, 14% to 16% of the seedlings developed reddish brown lesions on the coleoptile (figure 1). Many lesions then coalesced to form bigger and irregular lesions. Older lesions turned blood red to almost black and were surrounded by a reddish brown periphery (figure 2). Acervuli developed on the old diseased tissue of the coleoptile (figure 3).

Table 2. Percentage recovery of *Colletotrichum graminicola* from different parts of sorghum seeds. Observations based on 69 infected seeds of sample 10045 and 153 of sample 10046.

Sample accession number	Pericarp	Endosperm		Embryo
		Horny	Floury	
10045	97.1	24.6	8.6	1.4
10046	83.0	39.2	14.2	1.3

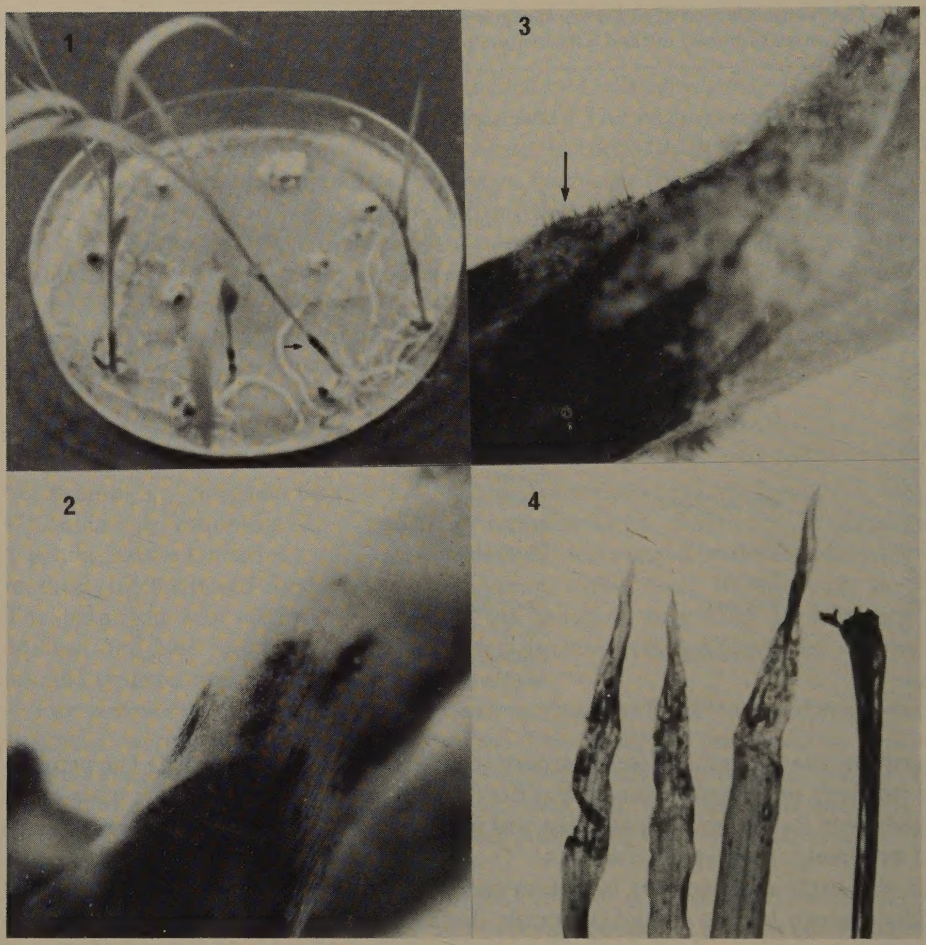

Figure 1. Lesions on the coleoptile of sorghum seedlings (arrow) produced by *Colletotrichum graminicola* in the water agar seedling symptom test.
Figure 2. Older lesions on the coleoptile.
Figure 3. Acervuli with prominent setae (arrow).
Figure 4. Symptoms on three young leaves, and leaf sheath (right).

Of the 200 seeds and seedlings transferred to peat soil, only 90 emerged and most of them showed drying of leaves from tip to base and were killed within two to three weeks. Disease development in some seedlings was slow. Differently coloured small, circular spots were observed on leaves of such seedlings (figure 4). Only five plants survived during the observation period of four months. These were, however, stunted compared to check plants and showed mild symptoms. *G. graminicola* was isolated

from all the 110 nongerminated seeds and 85 dead seedlings. The pathogen was recovered from the stalk up to the base of the third leaf in serial isolations but never from roots.

Discussion

Tarr (1962) has mentioned that *C. graminicola* is seed-transmitted, citing the work of Luthra (1932) and Chilton (1940). However, in the original papers, the two authors only refer to the presence of *C. graminicola* on seed but do not mention its transmission. In the present experiment, seed transmission was experimentally demonstrated by the water agar seedling symptom test wherein the pathogen moved from infected seeds to the coleoptile and to young seedlings. Further development in young plants was shown in a pot experiment and by positive serial isolations made up to the third leaf of dead plants. The only other crop where seed transmission of this pathogen has been reported is maize (*Zea mays* L.) (Böning and Wallner, 1936; Messian, 1955).

About 55% of the infected seeds did not germinate, indicating severe seed rot caused by the pathogen. This has been reported earlier by Leukel and Martin (1943). Information derived from component plating of seeds of two infected samples indicated that the pathogen is mainly located in the pericarp but also that it invades the horny and floury endosperm. Since the pathogen was isolated from only three embryos out of 222 tested, it appears that it is capable of attacking the embryo only in rare cases. The pathogen is thus primarily extraembryal in sorghum and probably may follow the type of disease cycle involving extraembryal infection followed by systemic infection. In bean, both extraembryal (Grümmer and Mach, 1955) and embryal infection of *C. lindemuthianum* (Sacc. & Magn.) Bri. & Cav. has been reported (Harter and Zaumeyer, 1944). Embryal infection of *C. dematium* occurs in lima bean (*Phaseolus lunatus* L.) and soybean (*Glycine max* (L.) Merr.) (Tiffany, 1951).

It is known that sorghum can be infected at any stage of its growth by conidia of *C. graminicola* (Tarr, 1962). Conidial inoculum from acervuli growing on infected nongerminated seeds and dead seedlings may serve as an additional source of infection, indicating another disease cycle: extraembryal infection followed by local infection.

C. gloeosporioides (Penz.) Sacc. has been reported on seeds of sorghum by Danquah (1972) and Rujirachoon (1974). Data available from routine testing at this Institute revealed the presence of *C. dematium* (Pers. ex Fr.) Grove and an unidentified species of *Colletotrichum* in sorghum seeds apart from *C. graminicola* and *C. gloeosporioides*. But in the present investigation only *C. graminicola* was observed.

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